DEPENDENCE OF STAR FORMATION RATE ON OVERDENSITY

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Abstract

We use a large-scale ΛCDM hydrodynamical simulation to assess the dependence of the cosmic Star Formation Rate (SFR) on overdensity of luminosity.

1. Introduction

The star formation rate (SFR) is the key measure that connects the structure formation in the universe and the actual observable light that is emitted by the galaxies. The plot of SFR as a function of redshift, known as the 'Madau Plot', depicts the evolution of the formation rate of stars in galaxies.

Using a large-scale hydrodynamical simulation, it was shown by Blanton et al. (1999) and Nagamine et al. (1999) that the gas which falls into gravitational potential-wells gets shock-heated, and the higher overdensity regions become no longer preferred sites for galaxy formation as the temperature increases towards the present.

Here we present the effects of this phenomena from different directions by analysing the SFR as a function of overdensity of luminosity. Details of the simulation can be found in the above two papers.

2. Star Formation Rate vs. Overdensity

The SFR is a direct output of our hydrodynamical simulation. Figure 1 shows the SFR divided into the quartiles of the light-overdensity distribution in V-band at z=0. The V-band luminosity of each stellar particle in the simulation was obtained using the latest isochrone synthesis model of GISSEL99 (Bruzual & Charlot 1999) with the metallicity of each particle taken into account.

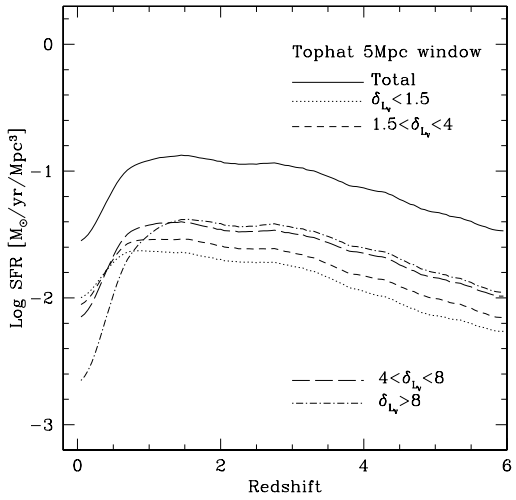

Fig. 1. SFR as a function of redshift, divided into the quartiles of the light-overdensity distribution in V-band at z=0.

It is clearly seen that the stellar particles in higher overdensity regions form earlier in time than those in lower overdensity regions. This is due to the effect which we described in the Introduction; the gas in high overdensity regions is shock-heated as it falls into the potential-well, thus further star formation is prohibited by the high temperature of the gas. Hence the steeper turn-off of the SFR between z=1 and 0. In lower overdensity regions, the gas is less heated than the higher overdensity regions and the peak of the SFR is at lower redshift.

Observationally, this is well known as the 'morphology-density relation' (eg., Dressler 1980). In clusters of galaxies, the old non-star-forming early-type galaxies dominate, whereas in the field, star forming late-type galaxies are seen more often. Also, the recent observations of galaxies in voids by Grogin & Geller (1999, 2000) find that the galaxies in the lowest density environments show stronger star formation than those in higher density region, which is consistent with what we find in Figure 1.

3. References

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